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An Innovative Neglected Invisible Hazard Identification (NIHI) at Workplaces; the Case of Athletics Hall Boroujen-Iran

HAMID SARKHEIL[1*]; JAVAD TAVAKOLI[1]; SOROUSH REZVANI[2]

[1]*Department of Environmental Engineering, College of Environment, Karaj, Iran;*

[2]*Goltash-Paxan Company, Isfahan, Iran.*

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ABSTRACT

In order to achieve safe conditions at workplace should correctly understand the concept of Hazard. In the hazard conceptual and common definition this means that dangerous event or situation that may lead to an emergency or disaster. It could also be a biological, chemical, or physical agent in (or a property of) an environment that may have an adverse health effect, or may cause injury or loss. As such, a hazard is a potential and not an actual possibility. Nowadays, all industrial managers try to achieve higher levels of safety knowledge and move to have a safer workplace (so most of the industrials and engineers are familiar with the concept of hazard even though this knowledge is not quite perfect). However, the volume of definitions and guidelines make this motion be stopped and caused confusion the management. Moreover in order to achieve a safer industry it is needed to know hazard better and use of more suitable methods to evaluate hazard and risk assessment in order to cover all bad condition in work place, activity and so on, and finally eliminate them to have safer industry. Then we need a more comprehensive look to define these concepts. In this study, we define new concept of hazard as visible and invisible hazard with more comprehensive look on-site Athletics Hall Boroujen in west Iran. We could innovatively, identify this group of hazard that means Neglected-Invisible Hazard (NIH) due to more focus on visible hazard.

KEYWORDS: *Hazard, Loss, Safety knowledge, Safer workplace*

INTRODUCTION

When the costs of workplace injuries, illness, and fatalities to the economy are also considered, the public health significance of developing effective occupational safety and health interventions is clear. As with other public-health concerns, a comprehensive intervention program will need which include one or more behavior-change strategies [1]. "Preventing injuries and illnesses in the workplaces is a never-ending job" [2]. Through job risk assessment and job hazard analysis, supervisors can focus on each task and the hazards associated with it to identify most of the potential causes of injuries. "Unsafe conditions and behaviors will only be eliminated after workers and management identifies what they are and why they exist" [3].

* Corresponding Author: Hamid Sarkheil

Email: Sarkheil_h@yahoo.co.uk

Risk is defined as a combination of an incident probability and its adverse consequence level. Risk analysis is a structural process which identifies both the incidents probabilities and the negative consequences imposed by a definite activity. Risk assessment is a process intended to estimate the risk to a given target organism, system or (sub) population, including the identification of attendant uncertainties, following exposure to a particular agent, taking into account the inherent characteristics of the agent of concern as well as the characteristics of the specific target system. Risk assessment refers to methods and techniques that apply to the evaluation of hazards, exposure and harm posed, which in some cases may differ from approaches used to assess risks associated with biological and physical agents, also in some cases risk assessment applied to antagonistic hazards [4]. The risk assessment process begins

with problem formulation and includes four additional steps: 1) hazard identification, 2) hazard characterization, 3) exposure assessment and 4) risk characterization [5-6] (Table 1). In occupational health and safety (OHS), the hazard is defined and used in many different ways [7]. According to OHS literature, one of concept to define hazard in OHS context is the concept of the hazard as a situation with potential for harm and damage. Also in other standards hazard is defined as a source of potentially losing energy [8], but One of the most definition for hazard is a physical or

chemical condition that has the potential for causing harm to people, property, or the environment [9-10]. "Hazard identification is generally the first step in a risk assessment" [11] and is the process used to identify the specific hazard and to determine whether exposure to this has the potential to harm human health. "For the purposes of this, hazard identification involves establishing the identity of the condition of interest and determining whether the condition has been considered hazardous by international organizations and, if so, to what degree" [12].

Table 1. Paradigm for risk assessment, including problem formulation (IPCS, 2009)

Step	Description	Content
Problem formulation	Establishes the scope and objective of the assessment	Defining the question Prior knowledge Desired outcomes
Hazard identification	Identifies the type and nature of adverse health effects	Human studies Animal-based toxicology studies In vitro toxicology studies Structure–activity studies
Hazard characterization	Qualitative or quantitative description of inherent properties of an agent having the potential to cause adverse health effects	Selection of critical data set Modes/mechanisms of action Kinetic variability Dynamic variability Dose–response for critical effect
Exposure assessment	Evaluation of concentration or amount of a particular agent that reaches a target population	Magnitude Frequency Duration Route Extent
Risk characterization	Advice for decision-making	Probability of occurrence Severity Given population Attendant uncertainties

A process for gathering information in support of hazard identification is illustrated in Fig.1. Thus, hazard identification involves two key tasks: (1) identification of specific undesirable consequences and (2) identification of material, system, process, and plant characteristics that could produce those consequences. The first task is relatively easy, but it is essential because it defines the scope of the second task. Undesirable consequences can be widely classified as human, environmental and economic impacts. Within these broad classifications, there may be specific consequence categories as illustrated in Fig.2 [9].

The notion of hazard is closely linked to the definition of risk, and it is important to distinguish between the two terms. "Risk is defined as a scenario with the possibility of creating damage, whereas a hazard is the potential source generating this damage" [13]. "Risk cannot be evaluated without first identifying the hazards involved. Many of the hazards will be identified by conducting a Process Hazards Analysis (PHA), e.g., such as HAZOP, What if/checklist, FMEA" [14]. While a hazard identification program is not

considered as a substitute for a formal Process Hazard Analysis (PHA), it is another important part of the risk management process. "It should be recognized that some "hidden" hazards are not easily detectable by front-line workers and others will be created by the workers themselves, therefore, there is a strong incentive to closely examine processes and equipment both before and during work to identify hazards and reduce the risk of an incident" [11].

Hazards may arise from a number of sources such as fires and explosions. They have the potential to do harm. A risk matrix (with rows and columns; severity versus likelihood) provides an adequate pseudo-measure or approximate gauging of risk. If Quantitative Risk Assessment is the chosen route then the method for calculating the agent components of the Risk Equation, to be specific, Consequence and Frequency, in the equation:

Risk = (Consequence of Incident) × (Frequency at which Incident Occurs)

The Consequence is evaluated in a number of steps and The Frequency may be evaluated in a number of ways. Risk may be analyzed as an indicator. It involves identifying hazards or examining what in a special situation could cause harm and damage or loss [11]. At this stage it may be felt, as with a HAZOP [12], or other forms of PHA which clear Hazards exist from four zones including people, equipment, materials and environment and help you identify seen and unseen hazards and risks in all four areas Fig.3.
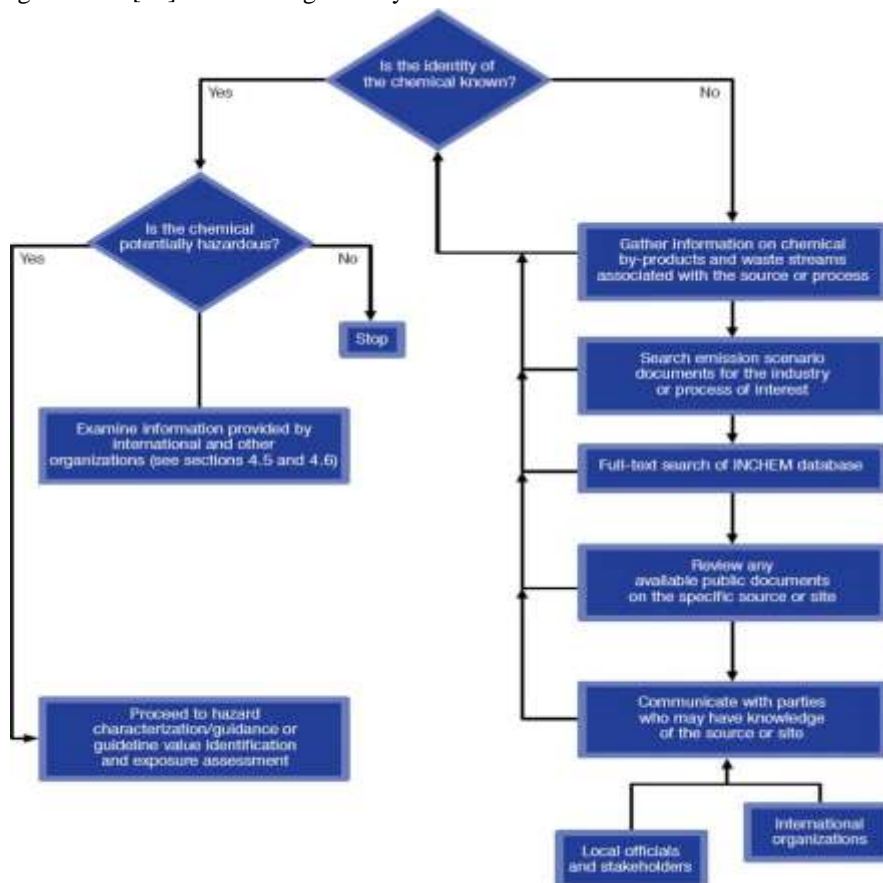
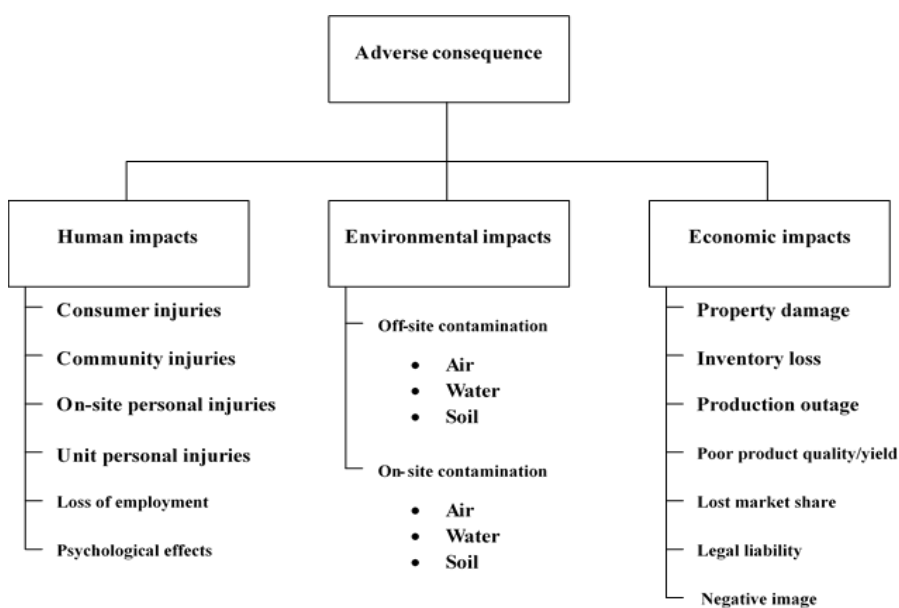**Fig.1.** Generic road map for hazard identification in the chemical industry

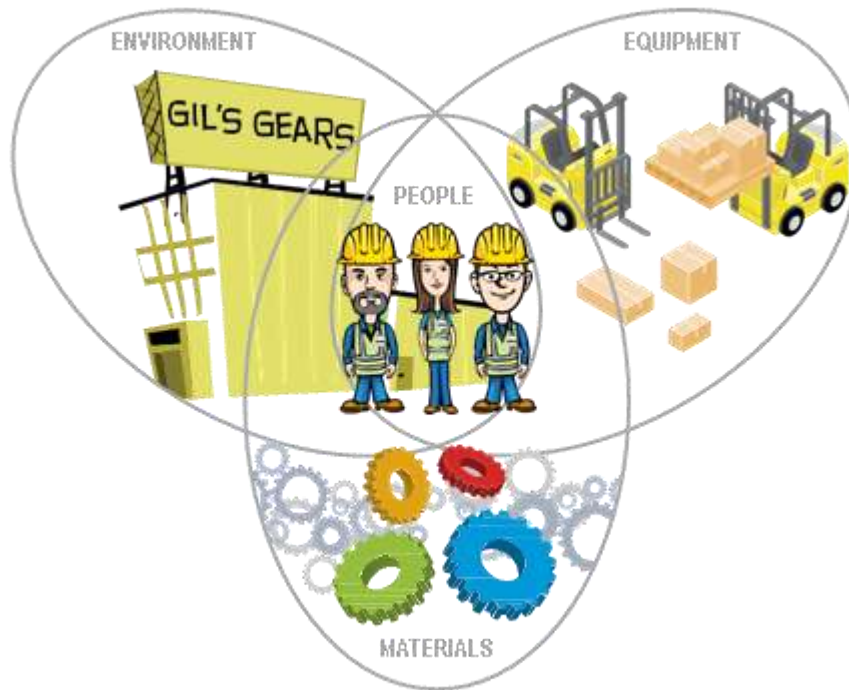**Fig.2.** Adverse consequences associated with process hazards

Fig.3. A schematic view of asset integrity in a company

The aim of this study was to introduce a new concept of hazard classification for hazard identification in industrial area. According to result of this study hazard classified in two universal new group which can help to risk analysis process. This classification of hazard condition, separated the hazard according to exposure level and type in other word this new hazard category help to facility of risk assessment process why hazards separate at first and hazard identification done better According to this classification and as noted above, hazard identification is first step of risk assessment and has a great effect on this.

MATERIALS AND METHODS

Despite some existing evidence of successful applications of safety processes, risk analysis and hazard identification there remain many knowledge gaps, unanswered questions, and thus many opportunities for research. The research categorized into two main categories: (a) introduce the new concept of hazard classification, (b) review and case-studies.

Introduce the new concept of hazard classification (NIH): A lot of different words are used when talking about "hazards" and "risk" - and sometimes these words are not used correctly. The words "hazard" and "risk" are often used interchangeably, when in fact they are very different. Using of known sources [15-16], does an excellent job of explaining the terms we use to describe hazard and risk. The following definitions and examples are adapted from this publication:

- **Hazard** - can be defined as a physical or chemical characteristic that has the potential to cause harm to people, property and to the environment. Certain unplanned events give rise to hazardous situation, resulting in accidents. An accident itself is due to the unplanned event or consequence of events resulting in undesirable losses.

- **Risk** - is the uncertain consequence of an event or an action on something with a given value. It always refers to a combination of two elements: the probability or chance of potential consequences and the severity of these consequences, linked to human activities, natural events or a combination of the two. Consequences of this type may be either positive or negative depending on the values associated with them. When deciding whether to cross the road, whether to eat healthy food, or what sports to participate in, we make judgments about the hazards involved and assess the risk before taking action. Just as there are risks in our everyday lives, so there are risks in activities that companies perform and in the products they make.

The Hazard Identification focuses on the process for identifying throughout life cycle—to make certain that risks to employees, the public, or the environment are systematically controlled within the risk tolerable by the organization [17]. So Hazard Identification is the most important step in risk analysis process as is first step of this process (Fig.4). According to Fig. 4 the recommendations from Hazard Identification require careful resolution and may represent changes to the processes/equipment, as well as to

process safety related policies, practices, and procedures. The output of the Hazard Identification also provides valuable information about what equipment and process safety practices either cause the relevant hazards, or safeguard against them. Therefore, the results of Hazard Identification have clear effect on process safety of plant. In other word everything that Facilitated the hazard identification program has a direct effect on level of safety in company. For this purpose, the hazards should be classified according to level of expansibility and type. This classification was introduced in this study.
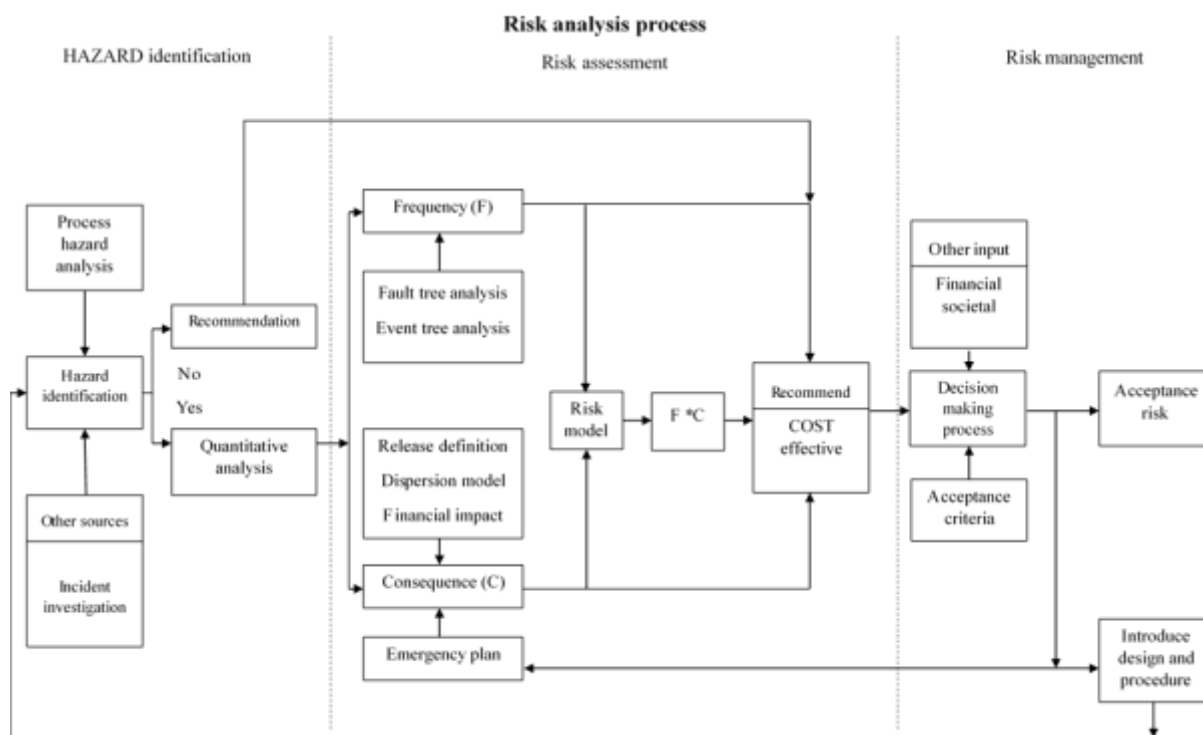

Fig.4. The analysis of Risk Stages

In this study, hazard will be categorized in two universal groups called visible hazard and invisible hazard that will be defined in general form as:

• **Visible hazard:** All hazards those are easier to know. Hazards that, their dangerous situations are easily understood by ordinary people and have a higher probability of detection and also the people that are around them sense by themselves in exposure to injury, harm and etc.

• **Unimaginable hazard:** "some hazards are hard or even impossible to identify using functional hazard identification sessions. Such hazards, are called (functionally) unimaginable hazards" [18].

• **Invisible hazard:** All hazards those are harder to know. Hazards that these dangerous situations are hardly understood by ordinary people and have a lower probability of detection and also the people that are around them do not sense own in exposure to injury, harm and etc. Indeed, this group of hazard means Neglected-Invisible Hazard (NIH) due to more focus on visible hazard.

For instance, we have got two wires which one of them was located at the height of 30cm above ground and the other is at the height of 5 cm. The events which occurred in effect of second wire is more than the first wire, because the first wire is classified in a visible hazard group while the second wire is classified in invisible hazard group. When a person senses own in a dangerous condition tried to do the works more carefully in comparison with the situation with no any sensitive dangerous condition. So, we can say the hazards that are categorized in visible hazard, have less probability to cause the event that is compared with invisible hazards and returns to human factors. It should be noted that this classification and concept of hazard only focuses on the probability of the occurrence of hazard in risk assessment and we cannot anything about severity. In other word a hazard may be classified in visible hazard group with low probability to occurrence, but it has high Risk Probability Number (RPN) because of the height of the severity level.

Introduce the Neglected Invisible Hazard Identification (NIHI):

A number of specific tools and techniques for hazards identification are summarized as:
• Brainstorming
• Hazard and Operability Studies (HAZOPS)
• Checklists
• Failure Modes and Effects Analysis (FMEA)
• Structured What-if (SWIFT)
• Dynamic Models
• Future Hazards Identification through FAST method

Another key method in the safety risk assessment process is Neglected Invisible Hazard Identification (NIHI), which is described as following steps:
1. Modified Checklists based in Fig.5.
2. Near miss retrospective assessment (identification, analysis and evaluation).
3. Compilation a monitoring procedure for NIHs detecting using mechanical instruments, documentation and comment box.

Fig. 5. Neglected Invisible Hazard Identification (NIHI) checklists, (Must be added to the Ordinary Hazard checklist)

RESULTS

Information about industry's experience with these approaches was done in a construction area. A better understanding of these experiences will help identify not only best or promising practices, but also the obstacles and barriers to successful implementations and the knowledge or practice gaps that provide opportunities for research. Detailed case studies also are important to illustrate common or unique experiences across various industry sectors and organizations. Case studies are especially informative when they illustrate process or organizational variables that are critical for success [19].

The study was carried out in a two arched roof of Athletics Hall Boroujen of the Iranian state construction company. About 120 employees worked in the unfinished buildings when the study was done in 2013. Using of a 2meters ladder with 7steps which was located at a height of 6 meters above ground on a roof Area of approximately 36m2, was recorded. The workers used it for climbing. The steps of ladder were low-named from 1 to 7. The duration use of the ladder was two, tree-hours period in every day from 9 to 12

and 14 to 17. During the 15 working day 482 Up and down of ladder by 25 different construction labors (which was Construction workers and welders) was recorded. Any one of them does not know anything about this study. Finally after this 15 working days, 17 near misses was recorded, which 11 of them occurred at the first three steps of ladder and others, occurred at Upper half (Table 2).

Table 2. Number of near miss in every step of ladder individually

Step	1st	2nd	3rd	4th	5th	6th	7th
Number of near miss	6	2	3	3	1	1	1

Hazards will be categorized in two universal groups called visible hazards (Hazards that their dangerous situations are easily understood by ordinary people and have a higher probability of detection and also the people that are around them sense by themselves in exposure to injury, harm and etc.). And invisible hazard (All hazards those are harder to know. Hazards that these dangerous situations are hardly understood by ordinary people and have a lower probability of detection and also

the people that are around them do not sense own in exposure to injury, harm and etc). At the 1st step of ladder, worker don't sense own in exposure to harm and work precipitous therefore this hazard, classified to invisible hazard and as can be seen from Table 2 the probability of this hazard was greater and 6 near miss of 17 near misses occurred at this step. This is despite the fact that the number of near miss that occurred at 7th step of ladder was just 1 near miss, because this hazard categorized at visible hazard and worker climbing of this step more carefully than other step of ladder.

Therefore, results and observation shows that the assumption about new concept of hazard is nearly correct and this definition is rather perfect and Comprehensive look about hazard concept and this classification.

CONCLUSION

Hazard identification program is first and most important component of risk management. The purpose of this study was to introduce a new concept of hazard classification for hazard identification in industrial area so that Guides the Hazard identification in a risk assessment process and improve this.

When use of this classification and definition, more important issues will be achieved Also, according to this theory, hazards was classified in three universal groups: visible hazard, invisible (Neglected Invisible Hazard) and Unimaginable hazard. It should be noted that around the visible hazard people observe safety precautions more than when they are near the invisible hazard, so that this is main cause of neglected invisible hazard. A clear example of this typically, most people use seat belt at Amusement Park because they sense dangerous condition but many of them do not use of it in his car.

To evaluate the right of this classification an industrial case was studied and result shown that First tree steps of ladder are classified in invisible hazard in fact when worker is in this location he forgets that the ladder is hazard yet. In other word he is less careful when is in this location. When the worker is in lower half of ladder the accident probability is more in compare with upper half. According to this observation when worker is at 7th step the accident probability is very low because he is careful but when he is going down the ladder his attention is coming down, as a result, the accident probability grows. Of course even though the accident probability of 7th step is lower than first step but the severity accident of 7th step is more than first step and may be the risk of 7th step is very more than first step. Indeed we don't say anything about great risk of hazards. Although different workers with distinct in type of work, work experience, age and responsibility may be effect on accuracy of this case study but can claim

that this definition of hazard can effect on Hazard Identification and Risk Analysis to deliver industrial plant to safer design and condition. This research should to develop in different location. The experience of worker and type of their work, state of work (emergency, normal, …) and human factor must to consider because they have a large impact on the result. We could not to consider this factor in this study.

ACKNOWLEDGEMENTS

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